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ABSTRACT

The study was undertaken to assess the needs of Alabama's industry for chemical technicians and to determine the kinds and levels of skills required by major employers. Of the 75 organizations responding to the questionnaire with usable data, 62 were private industries, 6 were testing laboratories, and 7 were federal agencies. Generally, the study indicated that the tremendous progress made by science has moved the professional chemist further into research, thus providing excellent employment opportunities for technical institute (two-year) or junior college graduates with training in chemical technology. These opportunities exist primarily in the petroleum, air pollution, water treatment, food, drug, chemical, glass, soap, rubber, paint, textile, power, steel, aluminum, and plastic industries. Respondents estimated that the need for chemical technicians in Alabama will almost double by 1976. The study presents an overview of the State's manpower needs for chemical technicians, makes future projections, delineates the skill/knowledge requirements desired by major employers, and describes current recommendations concerning the structure and content of an appropriate curriculum. (JR)

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CHEMICAL TECHNICIAN MANPOWER SURVEY: STATE OF ALABAMA

A

Report by

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And

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Summer, 1973

Published by

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PREFACE

This report identifies the needs of Alabama's industry for chemical technicians. It also describes the kinds and levels of skills desired for this worker by employers.

Instrumental in designing the plan of this Chemical Manpower Survey and supporting its implementation were Mr. Maurice Lind, Director of Computer Science, Jefferson State Junior College; Dr. Robert Garner, Associate Professor of Chemistry, Dr. Lena Prewitt, Associate Professor of Management and Manpower, and Dr. Thomas McLeod, Associate, Institute of Higher Education Research and Services, all of The University of Alabama.

This survey and report are supported, in part, by funds granted The University by the Carnegie Corporation of New York. This support does not imply endorsement by the Corporation of either the methodology employed or conclusions reached.

The survey was authorized and this report issued by the Institute of Higher Education Research and Services, an arm of The University of Alabama dedicated to the development of human resources and the continuing improvement of postsecondary educational institutions in Alabama and the South.

Summer, 1973

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TABLE OF CONTENTS

PREFACE . . . . . Page ii

INTRODUCTION. . . . . Page 1

PART I: The Demand For Chemical Technicians. . . . . Page 4

PART II: Industrial Requirements For Chemical Technicians . Page 6

PART III: Toward A Curriculum Model. . . . . Page 12

CONCLUSIONS . . . . . Page 17

Appendix A "Chemical Technician Manpower Survey". . . . . Page 18

Appendix B "Map of Alabama With The Seven Economic Areas Outlined". . . . . Page 23

Appendix C "Map of Alabama Indicating the Estimated Number of Chemical Technicians Currently Employed In Each of The Seven Economic Areas, and 1976 Projections For Each Area" . . . . Page 24

CHEMICAL TECHNICIAN MANPOWER SURVEY: STATE OF ALABAMA

INTRODUCTION

The Chemical Technician Manpower Survey was a study conducted by the Institute of Higher Education Research and Services of The University of Alabama, in conjunction with Jefferson State Junior College, Birmingham, Alabama. The study was undertaken to assess the needs of Alabama's industry for chemical technicians and determine the kinds and levels of skills required by major employers.

A total of 260 organizations were selected to participate in the study. They included 220 private industries, 20 testing laboratories, and 10 federal agencies.[1] Ninety-one organizations responded to the survey questionnaire, but only 75 questionnaires (or 82 percent) could be utilized for computer tabulation.[2] Of the 75 organizations tabulated, 62 were private industries, six were testing laboratories, and seven were federal agencies.

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[1]Difficulties in procuring a listing of the State agencies which employ chemical technicians resulted in their exclusion from the study.

[2]Appendix A presents the Chemical Technician Manpower Survey questionnaire used in this study. Nineteen organizations indicated on the cover of the Questionnaire, without responding to the questions, that they did not and/or would not need chemical technicians.

The term "chemical technician" was defined for purposes of this study as an employee who performs routine laboratory procedures involving chemistry as a significant part of a work assignment while working under the supervision of a professionally trained scientist.

Generally, the study indicated that the tremendous progress made by science has moved the professional chemist further into research, thus providing excellent employment opportunities for technical institute (two-year) or junior college graduates with training in chemical technology. These opportunities exist in the petroleum, air pollution, water treatment, food, drug, chemical, glass, soap, rubber, paint, textile, power, steel, aluminum, and plastic industries. Testing laboratories and federal agencies also provide good employment opportunities.

Approximately 57% of the respondents surveyed indicated that the starting annual salary for a chemical technician would be $6,000 or more. The respondents estimated that the need for chemical technicians in Alabama will almost double by 1976.

Most of the respondents indicated that chemical technicians should have at least "some knowledge" in the general education areas (e. g., communication skills, or the psychology of human relations); "good ability" in several supportive skills (e. g., sampling techniques, laboratory note recording, or arithmetic); "some ability" to work skillfully and safely with a myraid of laboratory apparatus and instruments; and "some knowledge" of basic chemical properties and vocabulary.

The study assumed that the feasibility of developing and offering

chemical technology programs will depend ultimately upon the degree to which they reflect the requirements desired by industrial employers of chemical technicians. Therefore, data from the study were tabulated and analyzed using three approaches: (1) statewide assessment of chemical technician manpower needs and desired training requirements, (2) assessment of each of seven economic areas in which the State is divided;[1] and (3) assessment of various types of industries, using product output as a basis of classification. These approaches assist in providing depth to the study.

The study findings are divided into three sections. Part I, "The Demand For Chemical Technicians," presents an overview of the State's manpower needs for chemical technicians, future projections, and other factors relevant to the career of chemical technicians.

Part II, "Industrial Requirements For Chemical Technicians," delineates the skill/knowledge requirements desired of chemical technicians by major employers.

Part III, "Toward a Curriculum Model," describes and interprets current recommendations concerning the structure and content of an appropriate curriculum.

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[1]Appendix B contains a map of Alabama with the seven economic areas as outlined by the Alabama Development Office pursuant to Executive Order of the Governor (June 14, 1971). Reference: Act No. 1126, Regular Session of the Alabama Legislature, 1969.

THE DEMAND FOR CHEMICAL TECHNICIANS

Today, professional chemists find it increasingly difficult to do much of the practical work required in their field. This is where chemical technicians contribute to technical progress. In 1970, approximately 69,500 people were employed in the United States as chemical technicians.[1] Most authorities believe that the number of chemical technicians should be double that of chemists and chemical engineers. Presently, the number of chemists and chemical engineers is about twice the number of chemical technicians.[2] By 1980, it is estimated that 214,000 trained technicians will be required by industry. The present rate of training - less than 1,000 new graduates per year - will not yield a supply of trained people adequate to meet the demand.[3]

According to the organizations surveyed at least 316 chemical technicians are employed presently in Alabama.[4] One hundred and ninety-five of these 316 technicians are employed in economic areas 1 and 6, respectively. Economic areas 2, 3, 4, 5, and 7 employ 29, 21, 48, 20, and 3 chemical technicians, respectively.[5] Organizations which manufacture chemicals

---

[1]Richard L. Harmon, "Industrial Laboratory Techniques on the High School Level," Journal of Chemical Education, Vol. 49 (November, 1972), 767.

[2]Kenneth Chapman, "A Different Career in Chemistry," Chemistry Vol. 41 (October, 1968), 20.

[3]Harmon, 767.

[4]Fifty-one organizations currently employ at least 1 chemical technician; 9 employ at least 5; 6 employ at least 10; and 8 employ at least 20.

[5]See Appendix C.

and allied products employ 190 of the 316 technicians while other significant employers are manufacturers of paper and allied products (44 technicians) and primary metal industries (24 technicians).

Based on projected changes (e.g., expansions, retirements), respondents of this survey estimate that at least 301 additional chemical technicians will be needed in industrial organizations in Alabama by 1976. Of this number, an estimated 85 additional technicians will be needed in economic area 1, 21 in area 2, 47 in area 3, 47 in area 4, 32 in area 5, 61 in area 6, and 8 in area 7.[1] This indicates that the chemical technician manpower demand in the State will almost double in the next three years.

When the job opportunities for a high school graduate are compared to those of a technical institute (2-year) or junior college graduate with training in chemical technology, over 62% of the organizations tabulated indicated that the job opportunities for the two-year college graduate are better than those for the high school graduate. When asked their organization's preference with respect to employing chemical technicians 41% of the respondents preferred fewer four-year college graduates, more two-year college technicians, and no high school technicians. Approximately 57% of the respondents indicated that the annual starting salary for chemical technicians who have completed two-year college or institute programs would be at least $6,000 or more.

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[1] See Appendix C for 1976 projections for each of the seven economic areas in the State of Alabama.

INDUSTRIAL REQUIREMENTS FOR CHEMICAL TECHNICIANS

In addition to assessing the demand for chemical technicians in Alabama, the Chemical Technician Manpower Survey also provided data delineating the training requirements desired by the respondents of persons employed as chemical technicians. The organizations surveyed indicated the amount of ability, knowledge, or experience desired by them with respect to the following:

1. general education
2. supportive skills
3. laboratory equipment
4. routine operations
5. specialized operations

When requested to indicate the amount of knowledge a chemical technician should have with respect to the general educational areas (i.e., communication skills, psychology of human relations, basic economics, and management), a majority of the respondents indicated that they wanted a chemical technician to have at least "some knowledge" in each of those areas. The area having the highest percentage (85%) of respondents desiring at least "some knowledge" (or better) was the area of communication skills. The area having the lowest percentage (59%) of respondents desiring the same was that of the psychology of human relations.

When the respondents were requested to indicate the ability desired by their organization with respect to supportive skills, a majority of them indicated that they wanted a chemical technician to have "good ability" in the following skills:

1. sampling techniques
2. laboratory note recording
3. arithmetic

A plurality of the respondents wanted "some ability" with respect to:

1. slide rule usuage
2. computation aids
3. report writing (technical)
4. use of library and scientific literature
5. algebra-trigonometry
6. statistics
7. graphing techniques
8. mechanics
9. electricity

Most of the respondents desired "no ability" with respect to the following supportive skills:

1. use of fortran
2. use of computers
3. logarithms
4. calculus
5. light, heat, sound
6. fluid mechanics

In terms of indicating the amount of knowledge a chemical technician should have with respect to laboratory equipment, a majority of the respondents specified that he should have a "good working knowledge" of pH meters and pH stats and analytical balances-semimicro (0.0001g). Most of them indicated that a chemical technician should have "some knowledge" of flame photometer-automatic absorbance equipment and

ultraviolet-visible spectrophotometers. A majority of the respondents indicated that a chemical technician needed "no knowledge" with respect to the following:

1. Cahn electrobalance-micro (<0.001g)
2. C, H, and N analyzers
3. vapor pressure osmometers
4. ultracentrifuges
5. liquid scintilation equipment
6. neutron activation spectroscopies
7. gel permeation chromatographs
8. preparative liquid chromatographs
9. polarographs
10. electroanalyzers
11. polarimeters
12. refractometers
13. ORD equipment
14. infrared spectrophometers
15. NMR spectrometers
16. mass spectrometers
17. electron microscopes
18. electrophoresis equipment
19. analytical gas chromatograph
20. preparative gas chromatograph

With respect to routine operations, most of the respondents indicated

a chemical technician should have a "good amount of experience" in:

1. titrimetric techniques
2. gravimetric techniques
3. density measurements
4. cleaning laboratory glassware
5. laboratory safety operations

They desire "some experience" in:

1. distillation
2. centrifugation
3. melting points
4. extractions
5. viscosity measurements

The operations where most respondents felt that "no experience" was needed were:

1. rotary or flash evaporation of solvents
2. recrystallization
3. setting up and carrying out laboratory scale synthetic reactions

Finally, when requested to indicate the amount of experience a chemical technician should have with respect to specialized operations, most of the respondents specified "some experience" with simple glass working and simple repairs of electrical and electronic equipment. They also indicated that "no experience" was needed with respect to:

1. ion exchanges
2. column chromatography
3. paper chromatography
4. thin-layer chromatography
5. high vacuum operations
6. techniques for handling radioactive isotopes
7. glove box operations
8. handling high pressure gases

A summary of the skills desired of persons employed as chemical technicians by the respondents is provided in Table 1.

Table 1

Summary of the Skills Desired of Persons Employed as

Chemical Technicians by Most Respondents to the Survey

A. Skills Most Needed:

1. sampling techniques
2. laboratory note recording
3. arithmetic
4. pH meters and pH stats
5. Analytical balances - semimicro (0.0001g)
6. titrimetric techniques
7. gravimetric techniques
8. density measurements
9. cleaning laboratory glassware
10. laboratory safety operations

B. Skills Needed:

1. communication skills
2. psychology of human relation
3. basic economics
4. management
5. slide rule
6. computation aids
7. report writing (technical)
8. use of library and scientific literature
9. algebra-trigonometry
10. statistics
11. graphing techniques
12. mechanics
13. electricity
14. Flame photometer - Automatic absorbance equipment
15. Ultraviolet - visible spectro photometer
16. distillation
17. centrifugation
18. melting points
19. extractions
20. viscosity measurements
21. simple glass working
22. simple repair of electrical and electronic equipment
3. logarithms
4. calculus
5. light, heat, sound
6. fluid mechanics
7. Cahn electrobalance - micro (<0.0001g)
8. C, H, and N Analyzer
9. Vapor Pressure Osmometer (or other molecular weight instruments)
10. Electrophoresis equipment or amino acid analyzer
11. Ultracentrifuge
12. Liquid scintilation equipment
13. Neutron activation spectroscopy
14. Gel permeation chromatograph
15. Preparative gas chromatograph
16. Analytical gas chromatograph
17. Preparative liquid chromatograph
18. Polarograph
19. Electroanalyzer
20. Polarimeter
21. Refractometer
22. ORD equipment
23. Infrared spectrophometer
24. NMR spectrometer
25. Mass spectrometer
26. Electron microscope
27. rotary or flash evaporation of solvents
28. recrystallization
29. setting up and carrying out laboratory scale synthetic reactions
30. ion exchange chromatrography
31. column chromatrography
32. paper chromatography
33. thin - layer chromatography
34. high vacuum operations
35. techniques for handling radioactive isotopes
36. glove box operations
37. handling high pressure gases

C. Skills Not Needed:

1. use of fortran
2. use of computers

TOWARD A CURRICULUM MODEL

Most employers of chemical technicians today prefer the graduates of two-year chemical technology programs.[1] This preference, coupled with the widespread demand for chemical technicians in the chemical laboratories of various types of industries, indicates that existing programs should be strengthened and additional chemical technology programs initiated. In addition to strengthening initial training opportunities, these actions will also contribute to the continuing career development of employed chemical technicians.

In July, 1969, the American Chemical Society (ACS) sponsored a Chem TeC Study to investigate post-secondary curricula for chemical technicians.[2] A Writing Team designed, tested, and wrote laboratory and text materials entitled Modern Chemical Technology. The team devised an Orbital Model of Chemical Education to provide a clear perspective of the differences between the approach to chemistry instruction for the chemist and the chemical technician. The model is displayed in Figure 1.

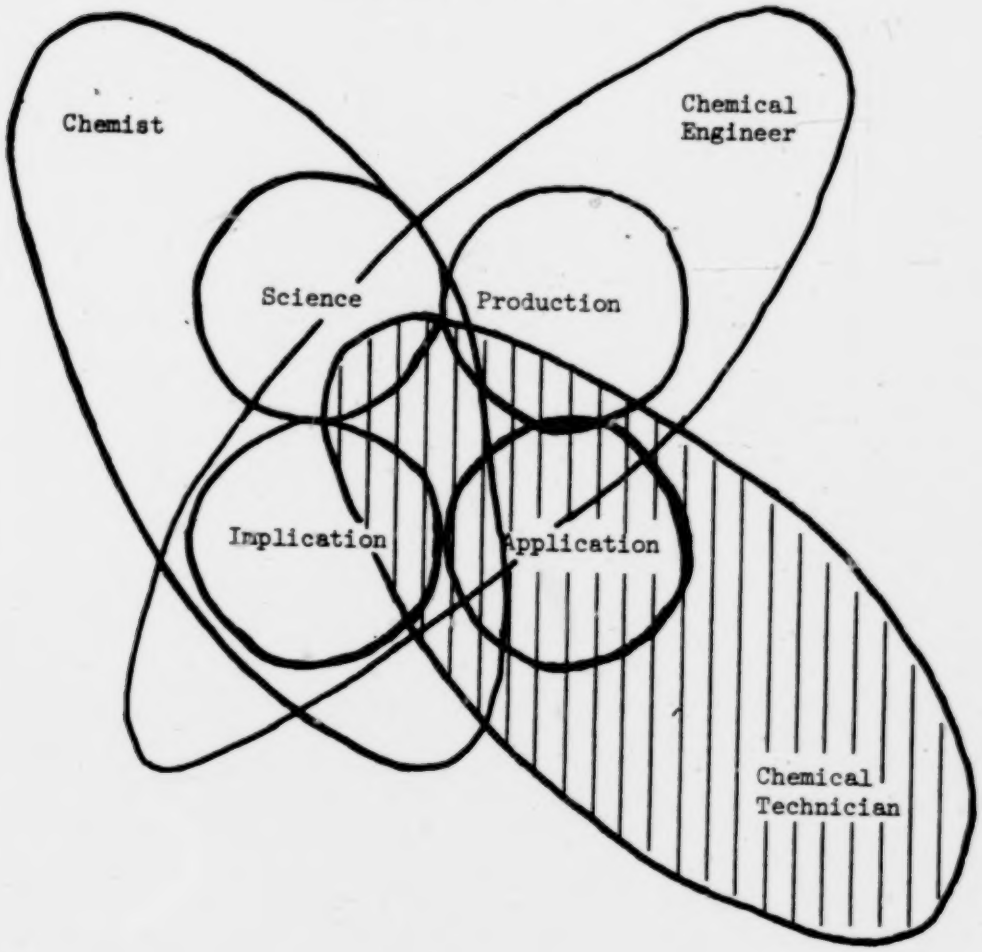
---

[1]Chapman, "A Different Career in Chemistry," 21. Most of the respondents to this Chemical Technology Manpower Survey indicated that they preferred two-year college technicians to high school or four-year college graduates.

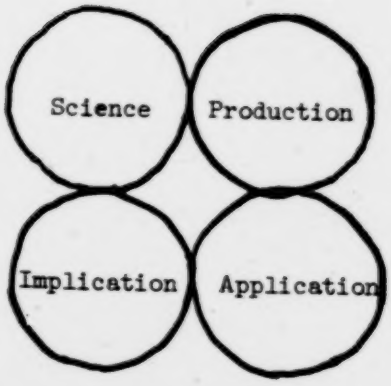
[2]Kenneth Chapman, "Chem TeC - Transfusion For A Tired Technology Program," Engineering Education, Vol. 62 (April, 1972), 835-36, provides an elaborate discussion of Chem TeC - Chemical Technician Curriculum Project.

Figure 1

Orbital Model of Chemical Education



The models and theories of chemistry data to clarify structure and properties.



Macro properties principally of interest to engineers.

The impact of chemistry in a technological society.

The "Bench-work" of chemistry. Experimentation and production of data. Interpretation to assure that data is valid and applicable to tests being performed.

The Writing Team drew the following conclusion concerning the Interest Orbitals for selected groups:

> [T]he Interest Orbitals of the chemist and chemical engineer are more closely centered on their respective subject matter areas than the chemical technician.... [Although] the chemist and chemical engineer must be thoroughly acquainted with all aspects of chemical laboratory activities....., it is the chemical technician who develops the precise skills required to assure greatest efficiency, highest yields from synthesis, best accuracy for measurements and minimum down time for instruments. This enables the chemical technician to exercise genuine creativity in his area of competence and interest. This attitude and perspective cannot be developed when the chemical technology program is really a junior chemist's program.[1]

A basic curriculum for chemical technicians should simulate industrial conditions in attitude and instrumentation. This simulation is important because it will give a student the knowledge and skills necessary for him to be immediately useful as a technician, upon successful completion of a chemical technology program.

Modern Chemical Technology suggests that a chemical technology curriculum have the following procedural features:

> 1. The program should be application-oriented; theories and concepts should be used as tools for understanding laboratory operations rather than as an end in themselves.
>
> 2. The laboratory work should be presented as an integral part of the text presentation. It may be desirable to arrange block schedules so that lecture, recitation, and laboratory classes are not separated by a clock.
>
> 3. The nature of the laboratory emphasis should give students the impression of doing "real chemistry." Experiments should use "real world" samples as often as possible. Concepts should frequently develop from experimental data rather than the experiments being used to "prove" concepts discussed in a lecture.

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[1]Chapman, 836.

4. The subdivisions of chemistry should not be accentuated, but rather the several areas should be integrated as to theory and concept throughout the program.

5. Mathematics should be made subservient to the chemistry. Calculus concepts should be used when applicable but the actual calculations done by students should be strictly in line with common laboratory practices arithmetic and algebra.[1]

In 1966, the ACS's Ad Hoc Technician Curriculum Committee developed a basic chemistry curriculum for training chemical technicians. The Committee recommended that a two-year core program encompass the following substantive components:

1. Basic chemistry

   a. Essential notions of atoms and molecules and stoichiometry

   b. Laboratory work introducing quantitative techniques for the preparation, separation, and characterization of simple "inorganic" substances, gravimetric and volumetric techniques.

2. Descriptive Chemistry I: "organic chemistry"

   a. The functional groups, structure and reactivity.

   b. Laboratory work in synthesis, separation, purification, and characterization using all techniques practicable at this level: extraction, distillation, chromatography, simple physical measurements.

3. Descriptive Chemistry II: "organic chemistry"

   a. Structure and reactivity, natural products.

   b. Laboratory work continuing previous studies, perhaps directed toward natural products wherever possible.

4. Descriptive Chemistry III: "inorganic chemistry"

   a. A broader perspective of the periodic table, nuclear chemistry, and radiochemistry.

   b. Physicochemical principles related to electrochemistry, radiochemistry, and "inorganic chemistry".

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[1]Chapman, 836.

5. Equilibria in solution and analysis

   a. Physicochemical principles related to equilibria, solubility, acid-base relations, buffers, complex formation.

   b. Laboratory work in quantitative applications of these principles.

6. Instrumental techniques

   a. Molecular structural principles appropriate to comprehension of advanced spectral methods (e. g., infrared, NMR, EPR, et cetera).

   b. Laboratory work in electrochemistry, applications of all instrumental techniques to both "organic" and "inorganic" systems.[1]

The foregoing outline identifies broad areas of chemistry which are appropriate to any curriculum for training chemical technicians. It would be presumptuous to be more specific in terms of content and order of presentation because individual circumstances (e. g., the background and preparation of the students, the interests of the instructors, the geographical environment, et cetera) may dictate concentration in one area or another for optimum success.

---

[1]"Chemistry Core Outline for Technicians," Chemical and Engineering News, Vol. 45 (May 22, 1967), 46-51.

CONCLUSIONS

The tremendous progress made by science has moved the professional chemist further into research, thus providing excellent employment opportunities for technical institute (two-year) or junior college graduates with training in chemical technology. These opportunities exist in many types of private industry. Testing laboratories and federal agencies also provide good employment opportunities.

Most employers surveyed indicated that the starting annual salary for a chemical technician would be $6,000 or more. The respondents estimated that the need for chemical technicians in Alabama will almost double by 1976.

Most of the respondents indicated that chemical technicians should have at least "some knowledge" in the general education areas; "good ability" in several supportive skills; "some ability" to work skillfully and safely with a myriad of laboratory apparatus and instruments; and "some knowledge" of basic chemical properties and vocabulary.

With industry's preference today for graduates of two-year chemical technology programs, the relatively high annual starting salaries, and the generally steady demand for the two-year technician, existing curricula should be strengthened, student recruitment efforts expanded, and the initiation of some new programs considered carefully.

Appendix A

Chemical Technician Manpower Survey

The University of Alabama's Institute of Higher Education Research and Services, in conjunction with Jefferson State Junior College, is conducting a survey to determine the needs of Alabama's industry for chemical technicians. Your responses to this questionnaire will be used to evaluate the feasibility of developing and testing appropriate institutional curricula for chemical technicians in cooperation with selected community colleges.

The term "chemical technician", as used in this questionnaire, refers to an employee who performs routine laboratory procedures involving chemistry as a significant part of his work assignment while working under the supervision of a professional trained scientist.

Complete the blanks at the bottom of the cover sheet before proceeding to the questions on the next 4 pages. Then respond to each question by circling one answer. Use any type soft lead pencil. If you respond to those questions/answers termed "other", please specify on the questionnaire. When answering questions 8 - 85, remember that no person may have all the skills checked, but for a group, each person should have a fair number of them.

Please complete the questionnaire and return it within 14 days in the enclosed envelope addressed to:

The Institute of Higher Education Research and Services
P. O. Box 6293
University, Alabama 35486

This survey is designed to develop viable programs to meet your manpower needs and your cooperation in taking the time to complete the questionnaire will be greatly appreciated. The information submitted by your organization will be held in complete confidence and utilized only for the purposes of this study. In no case will your response be interpreted as a commitment.

Name of Organization _____

Address _____ City _____

State _____ Zip _____

Name and Title of Person Completing Questionnaire: _____

_____

Chemical Technician Manpower Survey

1. Indicate the category which best describes your organization:
   a. private industry
   b. state agency
   c. federal agency
   d. testing laboratory

2. Indicate the number of chemical technicians presently employed by your organization:
   a. 0-4
   b. 5-9
   c. 10 - 19
   d. 20 or more

Based on probable changes (e.g. expansions, retirements, etc.); indicate the number of chemical technicians your organization will need for each year in the future:

3. In 1973:

   a. 0 b. 1-3 c. 4-6 d. 7 or more

4. In 1974:

   a. 0 b. 1-3 c. 4-6 d. 7 or more

5. In 1975:

   a. 0 b. 1-3 c. 4-6 d. 7 or more

6. In 1976:

   a. 0 b. 1-3 c. 4-6 d. 7 or more

7. Comparing advancement opportunities for a high school graduate to those for a graduate of a technical institute (2 years) or a junior college, indicate which one of the following statements is most applicable to your organization:
   a. advancement opportunities for the high school graduate are better than those for the two-year college graduate
   b. advancement opportunities for the two-year college graduate are better than those for the high school graduate
   c. advancement opportunities for both graduates are equal
   d. advancement opportunities are primarily determined according to local union rules.

Indicate the ability desired by your organization in the following supportive skills:

	No Ability	Some Ability	Good Ability
8. slide rule	a.	b.	c.
9. other computation aids	a.	b.	c.

10.	sampling techniques	a.	b.	c.
11.	use of fortran or other computer language	a.	b.	c.
12.	use of computer	a.	b.	c.
13.	laboratory note recording	a.	b.	c.
14.	report writing (technical)	a.	b.	c.
15.	use of library and scientific literature	a.	b.	c.
16.	arithmetic	a.	b.	c.
17.	algebra-trigonometry	a.	b.	c.
18.	logarithms	a.	b.	c.
19.	statistics	a.	b.	c.
20.	calculus	a.	b.	c.
21.	graphing techniques	a.	b.	c.
22.	light, heat, sound	a.	b.	c.
23.	mechanics	a.	b.	c.
24.	electricity	a.	b.	c.
25.	fluid mechanics	a.	b.	c.
26.	Other (specify) _____	a.	b.	c.
27.	Other (specify) _____	a.	b.	c.

Indicate the amount of knowledge a chemical technician should have with respect to the following general educational areas:

		No Knowledge	Some Knowledge	Good Working Knowledge
28.	communication skills	a.	b.	c.
29.	psychology of human relation (industrial psychology)	a.	b.	c.
30.	basic economics	a.	b.	c.
31.	management	a.	b.	c.
32.	Other (specify) _____	a.	b.	c.

Indicate the amount of knowledge a chemical technician should have with respect to the following equipment:

		No Knowledge	Some Knowledge	Good Working Knowledge
33.	pH meters and pH stats	a.	b.	c.
34.	Analytical balances - semimicro (0.0001g)	a.	b.	c.
35.	Cahn electrobalance - micro (< 0.0001g)	a.	b.	c.
36.	C, H, and N Analyzer	a.	b.	c.
37.	Vapor Pressure Osmometer (or other molecular weight instruments)	a.	b.	c.
38.	Electrophoresis equipment or amino acid analyzer	a.	b.	c.

39.	Ultracentrifuge	a.	b.	c.
40.	Liquid scintilation equipment	a.	b.	c.
41.	Flame photometer - Automatic absorbance equipment	a.	b.	c.
42.	Neutron activation spectroscopy	a.	b.	c.
43.	Gel permeation chromatograph	a.	b.	c.
44.	Preparative gas chromatograph	a.	b.	c.
45.	Analytical gas chromatograph	a.	b.	c.
46.	Preparative liquid chromatograph	a.	b.	c.
47.	Polarograph	a.	b.	c.
48.	Electroanalyzer	a.	b.	c.
49.	Polarimeter	a.	b.	c.
50.	Refractometer	a.	b.	c.
5	ORD equipment	a.	b.	c.
52.	Ultraviolet - visible spectro photometer	a.	b.	c.
53.	Infrared spectrophometer	a.	b.	c.
54.	NMR spectrometer	a.	b.	c.
55.	Mass spectrometer	a.	b.	c.
56.	Electron microscope	a.	b.	c.
57.	Other (specify)	a.	b.	c.
	_____	a.	b.	c.
58.	Other (specify) _____	a.	b.	c.

Indicate the amount of experience a chemical technician should have with respect to the following specialized operations:

		No Experience	Some Experience	Good Amount of Experience
59.	ion exchange	a.	b.	c.
60.	column chromatography	a.	b.	c.
61.	paper chromatography	a.	b.	c.
62.	thin - layer chromatography	a.	b.	c.
63.	high vacuum operations	a.	b.	c.
64.	techniques for handling radioactive isotopes	a.	b.	c.
65.	glove box operations	a.	b.	c.
66.	handling high pressure gases	a.	b.	c.
67.	simple glass working	a.	b.	c.
68.	simple repair of electrical and electronic equipment	a.	b.	c.
69.	Other (specify) _____	a.	b.	c.
70.	Other (specify) _____	a.	b.	c.

Indicate the amount of experience a chemical technician should have with respect to the following routine operations:

		No Experience	Some Experience	Good Amount of Experience
71.	distillation	a.	b.	c.
72.	centrifugation	a.	b.	c.
73.	melting points	a.	b.	c.

74.	rotary or flash evaporation of solvents	a.	b.	c.
75.	recrystallization	a.	b.	c.
76.	titrimetric techniques	a.	b.	c.
77.	gravimetric techniques	a.	b.	c.
78.	extractions	a.	b.	c.
79.	density measurements	a.	b.	c.
80.	viscosity measurements	a.	b.	c.
81.	setting up and carrying out laboratory scale synthetic reactions	a.	b.	c.
82.	cleaning laboratory glassware	a.	b.	c.
83.	laboratory safety operations	a.	b.	c.
84.	Other (Specify) _____	a.	b.	c.
85.	Other (Specify) _____	a.	b.	c.

86. Indicate the starting annual salary for a graduate of a technical institute (2 year) or a junior college who is employed by your organization as a chemical technician:

a. less than $4,000
b. $4,000 to $5,999
c. $6,000 to $7,999
d. $8,000 or more

87. Indicate your organization's preference with respect to employing chemical technicians:

a) prefer only four-year college graduates
b) prefer four-year college graduates, high school graduate technicians, and no two-year college technicians
c) prefer fewer four-year college graduates, more two-year college technicians, and no high school technicians.
d) Other (Specify) _____

88. Please list any additional comments you feel are pertinent to this study.

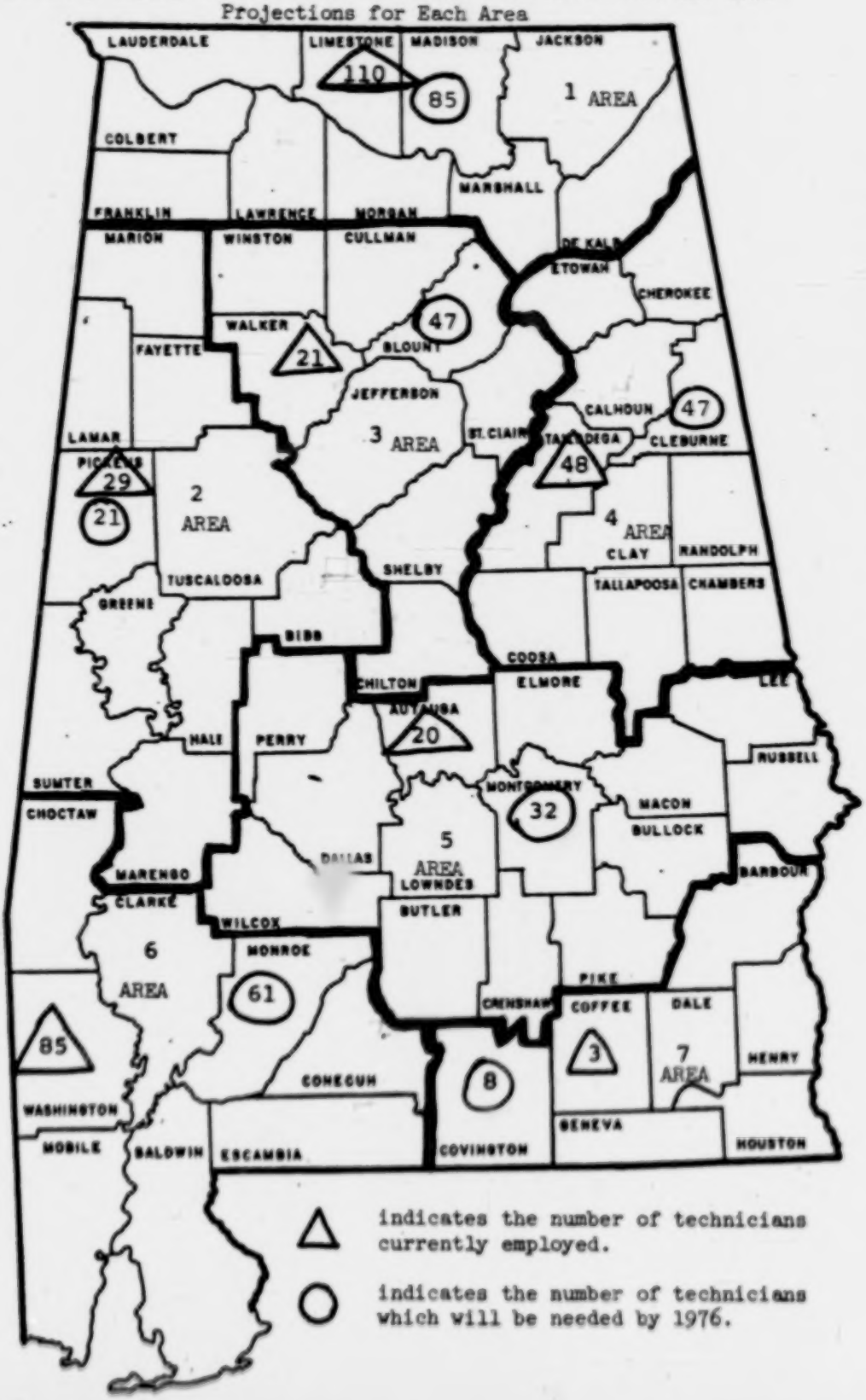
Appendix B

Map of Alabama With The Seven
Economic Areas Outlined*

*Prepared by the Alabama Development Office pursuant to the Executive Order of the Governor (June 14,1971). Reference: Act No. 1126, Regular Session of the Alabama Legislature, 1969.

Appendix C

Map of Alabama Indicating the Estimated Number of Chemical Technicians Currently Employed In Each of the Seven Economic Areas, and 1976 Projections for Each Area



△ indicates the number of technicians currently employed.

○ indicates the number of technicians which will be needed by 1976.